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## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P18232PC00/sko	<b>FOR FURTHER ACTION</b>	See Form PCT/IPEA/416
International application No. PCT/NO2004/000384	International filing date (day/month/year) 13.12.2004	Priority date (day/month/year) 15.12.2003
International Patent Classification (IPC) or national classification and IPC F15B11/042, F16L55/136, F16L55/132		
Applicant PLUGGING SPECIALISTS INTERNATIONAL ASA et al.		
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau) a total of 6 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>		
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>		
Date of submission of the demand  30.05.2005	Date of completion of this report  07.03.2006	
Name and mailing address of the international preliminary examining authority:   European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer  Rechenmacher, M  Telephone No. +31 70 340-4085	



# INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.  
PCT/NO2004/000384

## Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements**\* of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

### Description, Pages

1, 4-6 as originally filed  
2, 3, 7 as amended (together with any statement) under Art. 19 PCT

### Claims, Numbers

1-15 as amended (together with any statement) under Art. 19 PCT

### Drawings, Sheets

1/3-3/3 as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☒ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☒ the claims, Nos. 16
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/NO2004/000384

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty (N)	Yes: Claims	1-15
	No: Claims	
Inventive step (IS)	Yes: Claims	2,13-15
	No: Claims	1,3-12
Industrial applicability (IA)	Yes: Claims	1-15
	No: Claims	

2. Citations and explanations (Rule 70.7):

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.

PCT/NO2004/000384

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability;  
citations and explanations supporting such statement**

1 Reference is made to the following documents:

- D1: US-A-4 854 384 (CAMPBELL ET AL) 8 August 1989 (1989-08-08)
- D2: DE 196 31 804 A1 (MANNESMANN REXROTH GMBH, 97816 LOHR, DE) 15 January 1998 (1998-01-15)
- D3: WO 03/067134 A (CARSPHAIRN LIMITED; EARLY, CIARAN; GAGE, ERIC; MCTAVISH, DOUGLAS; EARL) 14 August 2003 (2003-08-14)

2 Inventive Step - Independent apparatus claim 1

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 does not involve an inventive step in the sense of Article 33(3) PCT.

2.1 The document D2 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses (the references in parentheses applying to this document; see the text passages cited in the search report and especially fig. 1):

Control system for a hydraulic cylinder comprising a cylinder chamber (8a), a piston head (12) and a piston rod (12), which control system () comprises a fluid line (6, 9) between at least on[e] side of the hydraulic cylinder's piston head (12) and a source of hydraulic fluid, which fluid line (6, 9) comprises at least in a part two parallel lines (6, 9) in which [in] a first of the lines (6) there is arranged a pump (1), wherein the other second parallel line (9) comprises a control element (10, 11), which allows less fluid through the second line (9) in the opposite direction of the pump (1), than the pump [delivers] in the first line (6) when the pump is running, which control element (10, 11) has a neutral open position and allows fluid through the second line (9) when the pump is not running, (...).

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.

PCT/NO2004/000384

The expressions in brackets printed in bold characters (e.g. "[**delivers**]") show how the claim was interpreted.

- 2.2 The subject-matter of claim 1 differs in that the control element (21, 25) is relieving the pressure of the high pressure side of the hydraulic cylinder when the pump is not running.
- 2.3 However, a surprising effect solving the technical problem described in the description ("plug which is easier to produce and maintain" and that "gives the necessary security in the setting and releasing procedure") is only achieved in connection with a plug.
- 2.4 Therefore claim 1 does not involve an inventive step (Article 33(3) PCT).

3 Dependent claim 2

Claim 2 comprises all features of claim 1 and is therefore regarded as being dependent on claim 1. In view of the prior art cited in the search report claim 2 appears to fulfil the requirements of the PCT with respect to novelty and inventive step (Article 33(2) and 33(3) PCT).

4 Dependent claims 3-12

As such the additional features of these claims do not involve an inventive step because these features are either known from the cited prior art or obvious to the skilled person. However, claims 3-12 are considered inventive if dependent on claim 2.

5 Independent method claims 13 and 14 and dependent claim 15

In view of the prior art cited in the search report these claims appear to fulfil the

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.

PCT/NO2004/000384

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requirements of the PCT with respect to novelty and inventive step (Article 33(2) and 33(3) PCT).

Another use for removable plugs are if valve elements need to be maintained, a new field should be added to a main pipeline or even in the case where a water pipe from for instance a water dam has to be mended or replaced. The plugs may be used in pipes with a pressurized fluid. If the plug is of a kind with no cable feed it may be use  
5 wherever in the length of the pipe.

Prior art plugs are of a kind having anchoring and sealing means operated by at least one hydraulic cylinder with a control system, with a control valve which is closed in a neutral position, i.e. the valve is only open when energy is feed to the valve. The plug is set by feeding energy to the valve so it goes to an open position, hydraulic fluid is  
10 pressurized through the valve to the hydraulic cylinder and the hydraulic cylinder is setting the anchoring and/or sealing means. When the plug is set, the energy is cut off to the valve and it closes, with the hydraulic cylinder in a pressurized position, with the anchoring and or sealing means in a set position.

For releasing the plug a signal and energy has to be feed to a valve in the plug to open the valve to relieve the pressurized hydraulic fluid in the hydraulic cylinder – to be able to retract the anchoring and sealing means as for instance described in US 4 854 384 and WO 03/067134. This releasing procedure is a critical procedure, and normally there is at least one backup system for this in the plug, in case the procedure does not work, either due to lack of available energy, damage to the control line, a stuck valve or other  
15 incidents. To get a necessary security in this system, when talking about a central pipeline from a large oilfield, there is as mentioned at least one and normally several backup system. These backup systems take vital room in the plug and make the plug more complicated - both in production and also in maintenance. Several elements and systems in the plug make the plug also less reliable.

It is an object of the present invention to provide a control system for a hydraulic cylinder which may be used in a plug, which may release the hydraulic cylinder without energy supply to elements in the plug. There is also an object to provide a plug which is easier to produce and maintain and at the same time gives the necessary security in the setting and releasing procedure. There is also an object to provide a plug  
25 and a method for setting and releasing the plug which plug and method do not need additional back-up systems for securing the release of the plug. To obtain a more reliable plug is also an object of the invention.

A control system for a hydraulic cylinder, a plug with a hydraulic cylinder and method for setting and releasing a plug wherein the above mentioned objects are achieved is  
35 obtained with a control system, plug and methods according to the independent claims. Further features of the invention appear from the dependent claims.

A control system according to the invention is used for a hydraulic cylinder. With the term hydraulic cylinder it is meant a cylinder with endplates and a piston head

within said cylinder and a piston rod running from said piston head and out of said chamber on one or both sides of the piston head. The control system for the hydraulic cylinder comprises a fluid line between at least on side of the hydraulic cylinder's piston head and a source of hydraulic fluid. This fluid line comprises in at least a part  
5 two parallel lines. In one of the lines is there arranged a pump. The other parallel line comprises a control element. This control element allows less fluid through the line in the opposite direction of the pump, than the pump when the pump is running. The control element has further a neutral open position and allows fluid through when the pump is not running, relieving the pressure of the high pressure side of the hydraulic  
10 cylinder.

The invention also regards a plug with anchoring and sealing devices operated by at least one hydraulic cylinder, which is operated by a control system for setting and/or releasing the plug. The hydraulic cylinder may operate both anchoring and sealing devices or just one of them or there may be several hydraulic cylinders for operation of  
15 for instance the anchoring system.

The plug according to the invention is used for closing of a pipeline for the stream of a fluid. The pipeline is normally a gas and or oil pipeline but may also be a pipeline or pipe or tube for any other fluid. The plug is preferably remotely operated, but can be operated by control lines running through the pipeline to an entry point.

20 The control system for the hydraulic cylinder comprises according to the invention, a fluid-line between at least on side of the hydraulic cylinder's piston and a source of hydraulic fluid. Between these two points there is for at least a part of the line, two parallel lines where one of them comprises a pump and in the other line is there arranged a control element. This control element is of a kind that allows less fluid  
25 through this line in the opposite direction of the pump, than the pump when the pump is running.

The control element may be a restriction orifice or a valve, which valve according to the present invention in a neutral position is open.

30 This means that the valve have to be feed a signal and energy to be switched to a closed position, where after or at the same time the motor is turned on and thereby running the pump and hydraulic fluid is feed into the hydraulic cylinder to set the plug in the pipeline. By setting the plug it is meant using the anchoring means for positioning the plug in the pipeline and hold it there and thereafter or simultaneously pressing the sealing devises of the plug against the inner surface of the pipeline to prevent fluid  
35 moving from one side of the plug to the other side of the plug.

When the plug is set and there is a differential pressure across the plug the signal and energy to the valve and motor is turned off and the valve goes back to its neutral position; which is open. The hydraulic pressurized fluid in the hydraulic



fluid in the pipeline is relieved on one side of the plug 2, and when a predetermined pressure difference between the two sides of the plug is noticed by the pressure transmitters then the pump is stopped and the valve is left in its neutral position, which is an open position. This position of the valve is shown in fig. 1. The spring 15 is in this position pressed together and will help force the anchoring means to a retracted position when there is less pressure differences between the two sides of the plug again. The spring 15 is however not necessary.

Fig. 3 shows another embodiment of the control system according to the invention. The control system is regulating a hydraulic cylinder in a plug 2 in a pipeline 1, which hydraulic cylinder is operating the anchoring devices 3 and sealing devices 4 of the plug 2. The hydraulic cylinder has a through going piston rod 13, which runs through the whole cylinder chamber 11 wherein the piston head 12 is situated. The hydraulic cylinder 8 is in this case also preloaded with a spring 15 situated between an endplate 5 of the plug and an endplate 10 of the cylinder chamber 11. The line 20 in the control system runs from a first opening 18 in one of the sub-chamber of the cylinder chamber 11 to a second opening 19 in the other sub-chamber of the cylinder chamber 11. In a part of the line 20 is there arranged two parallel lines 20a and 20b. In the first of these lines 20a is there arranged a pump 22 with a motor 23, in the other line 20b is there arranged a restriction orifice 25. This restriction orifice 25 has a maximum through flow which is much smaller than the capacity of the pump 22 when the pump 22 is running. By this one achieves that when the pump 22 is running, a pressure is built in the hydraulic cylinder 8 on one side of the piston head 12, even though there is some return flow of fluid through the restriction orifice 25. When the pump 22 is turned off the level of pressure in the hydraulic cylinder 8 on the pressurized side of the piston head 12 will slowly decrease until there is equal pressure between the "pressurized side" of hydraulic cylinder and the source of hydraulic fluid, since the fluid slowly will flow back through the restriction orifice 25. The source of hydraulic fluid, in the case shown in fig. 3, is on the other side of the piston head 12.

The invention has now been explained with a preferred embodiment, but the skilled person will be able to do modifications and alterations within the scope of the invention as defined in the claims. For instance may there be several hydraulic cylinders operating the plug and there may be one or several control systems for operating these. The control system for the hydraulic cylinder may be fully or partly situated within the hydraulic cylinder itself. There may be several packers for establishing a double barrier etc.

## CLAIMS

1. Control system for a hydraulic cylinder comprising a cylinder chamber (8), a piston head (12) and a piston rod (13), which control system (14) comprises a fluid line (20) between at least on side of the hydraulic cylinder's piston head (12) and a source of hydraulic fluid, which fluid line (20) comprises at least in a part two parallel lines (20a, 20b) in which a first of the lines (20a) there is arranged a pump (22), wherein the other second parallel line (20b) comprises a control element (21, 25), which allows less fluid through the second line (20b) in the opposite direction of the pump (22), than the pump in the first line (20a) when the pump is running, which control element (21, 25) has a neutral open position and allows fluid through the second line (20b) when the pump is not running, relieving the pressure of the high pressure side of the hydraulic cylinder.
2. Plug for closing off a pipe (1), comprising anchoring (3) and sealing (4) devices operated by at least one hydraulic cylinder (8) with a control system (14) for setting and/or releasing the plug (2), which control system (14) comprises fluid line (20) between at least on side of the hydraulic cylinder's piston head (12) and a source of hydraulic fluid, wherein the fluid line (20) comprises two parallel lines (20a, 20b) in which a first of the lines (20a) there is arranged a pump (22), and the other second parallel line (20b) comprises a control element (21, 25), which allows less fluid through the second line (20b) than the pump (22) in the first line (20a) when the pump is running, which control element (21, 25) has a neutral open position and allows fluid through the second line (20b) when the pump is not running, relieving the pressure of the high pressure side of the hydraulic cylinder.
3. Control system or plug according to one of the preceding claims, wherein the control element is a valve (21) with at least an open and closed position, where its neutral position is open.
4. Control system or plug according to claim 1 or 2, wherein the control element is a restriction orifice.
5. Control system or plug according to claim 3, wherein the valve (21) with energy feed will be switched to a closed position.
6. Control system or plug according to one of the preceding claims, wherein the source of hydraulic fluid is an accumulation tank and or the void on the other side of the piston head (21).
7. Control system or plug according to one of the preceding claims, wherein the hydraulic cylinder has a piston rod (13) running through both sub chambers of said cylinder chamber (11).

14. Method for releasing a plug (2) in a pipe (1), which plug (2) comprising anchoring (3) and sealing (4) devices operated by at least one hydraulic cylinder (8) with a control system (14) comprising fluid lines (20) from at least one side of the hydraulic cylinder's piston head (12) to an accumulation tank and or to the other side of said piston head (12), and in the fluid lines (20) a pump (22) with a motor (23), and in parallel with the pump (22) a valve (21) where the valve (21) in its neutral position is open, wherein

building pressure on the non-pressure side of said plug (2),

when said pressure reaches a value will the preloaded hydraulic cylinder (8), with the open valve (21) in the control system (14), move the anchoring means (3) to a retracted position and the plug (2) is free.

15. Method according to claim 14, wherein the valve (21) is set to a closed position and the pump (22) is run in an opposite direction and the hydraulic cylinder (8) retracts the anchoring means (3).

8. Control system or plug according to one of the preceding claims, wherein the fluid lines (20) for the control system (14) is connected to the cylinder chamber (11) on both sides of said piston head (12).
9. Control system or plug according to one of the preceding claims, wherein hydraulic cylinder (8) is preloaded to return to a neutral position where the anchoring means (3) are in a retracted position.
10. Control system or plug according to claim 9, wherein the preloading is provided by at least one spring (15) between an endplate (5) of the plug and an endplate (10) of the hydraulic cylinder (8).
11. Control system or plug according to one of the claims 2,3 or 5-8 wherein the pump (22) is a two-way pump.
12. Plug according to one of the claims 2-11, wherein the plug comprises a first endplate (5) and a second endplate (6), a cylinder chamber (11) connected to the second endplate (6), which cylinder chamber (11) comprises a piston head (12) with a piston rod (13), which runs through said piston head (12) and through whole of said cylinder chamber (11), sealing means (4) in form of a packer arranged in abutment to an inner side of said first endplate (6), and a first part of said anchoring means (3) in the form of a first wedge behind said packer, a second part of said anchoring means (3) provided partly outside said first part of said anchoring means (3) and in abutment against the first endplate (5) of said plug, where said first endplate (5) is connected to said piston rod (13).
13. Method for setting a plug (2) in a pipe (1), which plug (2) comprising anchoring (3) and sealing (4) devices operated by at least one hydraulic cylinder (8) with a control system (14) comprising fluid lines (20) from at least on side of the hydraulic cylinder's piston head (12) to the other side of said piston head (12) and or an accumulation tank and in the fluid lines (20) a pump (22) with a motor (23), and in parallel with the pump (22) a valve (21) wherein,
- inserts the plug (2) in the pipe (1),
  - move it to the required position in the pipe (1),
  - activate setting procedure by starting said pump (22) and build a necessary setting pressure in the hydraulic cylinder (8),
  - relieve the pressure on one side of said plug (2) until a sufficient differential pressure established across the plug (2), and wherein when starting said pump the valve (21) is set in a closed position, and after a sufficient differential pressure is established stop the pump (22) and release the valve (21) to its neutral position, an open position.